Monitoring Issues in the GOA Groundfish Rationalization Program

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The Council is currently in the process of developing alternatives for its Gulf of Alaska (GOA) groundfish rationalization program. Successful implementation of a rationalization program in the GOA will depend on the development of a practical and cost-effective monitoring program to ensure that groundfish and prohibited species (PSC) catches are properly accounted. The purpose of this discussion paper is to identify the monitoring issues that are likely to be associated with the GOA rationalization program, and explore a variety of monitoring approaches.

NMFS currently manages the groundfish fisheries of the GOA by using a combination of reports from observers and processors. The current system was designed to provide the data necessary to manage aggregate groundfish and PSC quotas in open access fisheries. Under the current system, data reported to NMFS by catcher processors, shoreside processors and at-sea observers are combined to generate aggregate estimates of total removals for each groundfish species or species group. PSC rates from observed vessels are extrapolated to provide estimates of total PSC bycatch on a fishery-by-fishery basis. This system is appropriate for the current open access fisheries in the GOA where TACs and PSC limits are managed in the aggregate. However, the current system is inadequate for monitoring rationalized fisheries because it was not designed to provide estimates of catch and bycatch on an individual vessel basis.

Because the GOA rationalization alternatives are still under development, it is not possible to spell out in great detail the type of monitoring that will be necessary to implement the program. And this paper does not attempt to do so. However, given the direction of the alternatives as they have progressed to date, it is possible to identify some of the monitoring issues that are likely to arise, and suggest some alternative approaches for monitoring catch and bycatch that may merit further analysis.

The first section of this paper summarizes the types of monitoring requirements that are likely to arise under the alternatives currently under consideration. This section concludes that a system of individual vessel halibut PSC harvest shares[1] will the most problematic and difficult element of the program to monitor. The other aspects of the GOA rationalization program, such as the allocation of groundfish harvest shares or individual fishing quotas (IFQs) to individual fishermen, do not raise such difficult monitoring issues, and likely could be implemented using a combination of the methods currently used to monitor other individual quota-based fisheries such as the halibut/sablefish IFQ program, the Community Development Quota (CDQ) program, and the American Fisheries Act (AFA) pollock management program.

The second section of this paper focuses options for implementing and managing individual vessel halibut PSC harvest shares, and discusses the level of monitoring that is likely to be required under various alternative approaches. This section of the paper concludes that halibut PSC harvest shares

[1]Also known as vessel bycatch allowances (VBAs) or individual bycatch quotas (IBQs).

(issued to either vessels or cooperatives) are likely to be exceedingly costly to implement if the program relies on observer coverage to monitor the actual halibut bycatch of individual vessels. For some of the smaller vessel size classes, the costs of observer coverage could even exceed the net revenues from the fishery. However, maintaining the current system of aggregate PSC limits is also problematic because to do so would simply create a race for fish in the fisheries in which halibut PSC limits are a controlling factor.

For this reason, the Council may wish to explore additional approaches to monitoring and regulating halibut PSC so that the objectives of rationalization can be achieved in a cost-effective manner. To this end, a variety of alternative approaches to PSC management are suggested at the end of this discussion paper. Given the disparate nature of the different GOA groundfish fisheries, the Council may wish to explore a variety of approaches for PSC management that can be individually tailored to each individual fishery. The paper merely serves as a starting point in that discussion, as some of the suggestions contained within are only rough ideas that have in no way been thoroughly developed or analyzed. At a minimum, the Council should ensure that the environmental impact statement currently under preparation contains a thorough analysis of PSC monitoring alternatives so that problems and cost-effective solutions can be identified.

1.0 Elements of the GOA Groundfish Rationalization Program that require monitoring and oversight

While the GOA groundfish rationalization alternatives have not been finalized in great detail, many of the activities that will require monitoring are common to the alternatives. These may be grouped into four general categories for the purpose of this discussion paper:

- Individual vessel fishing activity. These are the elements of the management program that must be monitored at the individual vessel level such as groundfish IFQs and individual vessel halibut PSC harvest shares.

- Fishery-wide fishing activity. These are elements of the management program that can be monitored at the fishery level. Examples include the tracking of marine mammal and seabird interactions, which are monitored fishery-by-fishery but are not regulated at the individual vessel level.

- Cooperative formation and operation. Some of the alternatives contain a host of regulations that govern the formation and operation of fishery cooperatives. Considerable monitoring and oversight may be required to ensure that cooperatives form and operate in the manner intended by the Council.

- Processing activity. In the inshore sector, much of the monitoring of groundfish IFQs is likely to occur at the shoreside processor where catches are sorted and weighed. In addition, regulations that implement a closed class of processors or establish linkages between processors and cooperatives will require additional monitoring and oversight to ensure a level playing field and to ensure that processors are operating within the constraints imposed on them by the program

1.1 Individual vessel fishing activity

Regardless of the form that the GOA rationalization ultimately takes, increased monitoring of individual vessel fishing activity will be necessary because quotas and bycatch limits that were previously allocated at the fishery level will now be allocated to individual vessels or cooperatives. The types of activities that will need to be monitored at the individual vessel level include the following:

- Catch and discards of groundfish species for which IFQs have been assigned.
- Bycatch of PSC species for which individual vessel harvest shares have been assigned.
- Time and location of fishing activity.
- Other restrictions on the use of IFQ (owner-on-board requirements, leasing restrictions, gear restrictions, vessel size limits, processing restrictions, etc).

1.1.1 Groundfish catch and discards

NMFS has a decade's worth of experience with monitoring groundfish catch and bycatch at the individual vessel level in the halibut/sablefish IFQ and CDQ fisheries, and more recent experience monitoring individual vessel activity in the AFA pollock fishery. The experiences with these three programs is likely to guide the Council and agency in developing an individual vessel monitoring program for GOA rationalization. Experience with all three programs suggests that the processing location is the most efficient and cost-effective place to monitor the catch of IFQ species. For catcher vessels, landings are most efficiently monitored at the processor, where deliveries can be sorted and weighed on certified scales, and the weighing process can be monitored.

Catcher processors vary considerably in terms of size and type of operation. On larger catcher processors such as those that operate in the AFA pollock fishery, total catch can be effectively measured onboard the vessel using flow scales. On small catcher processors such as the freezer longliners that operate in halibut/sablefish fishery, at-sea scales may not be practical. On such vessels, landings may be most efficiently monitored by weighing products at the time of offload and back-calculating using product recovery rates (PRRs) to determine total catch as is currently done in the halibut/sablefish IFQ program.

Monitoring groundfish landings by catcher vessels

Experience with other quota-based programs suggests that the retained catch of catcher vessels is most effectively measured at the processor location. Most catcher vessels, especially those operating in the GOA, simply do not have the capacity to install at-sea scales that would provide the same level of accuracy as the certified scales installed at the processing plant. Likewise, at-sea observer estimates of groundfish catch that are based on extrapolated basket samples cannot approach the level of accuracy provided by certified scales installed at the processing plant. Furthermore, it is more cost-effective in terms of equipment and personnel to weigh the catch of multiple vessels at a single shoreside location rather than at-sea with separate scales installed on each individual vessel. Some quota-based programs in other countries use at-sea scales to monitor catcher vessel landings. But that approach is likely not practical in the GOA groundfish fishery given the number of small vessels and the diversity of vessels and gear types.

In the quota-based programs established in Alaska to date, NMFS has taken two different approaches to monitoring shoreside landings of quota species. For the halibut/sablefish IFQ program, NMFS developed a program that relies on NMFS enforcement officers to monitor landings and enforce compliance with

catch weighing and catch accounting regulations. In contrast, the CDQ and AFA shoreside monitoring programs in the Bering Sea rely primarily on observers to verify that catch is being sorted and weighted in an accurate manner.

While all three of these programs rely to a great extent on industry-reported data, the presence of enforcement officers and observers provides NMFS with the ability to verify compliance and ensure that quotas are accounted for in fair and accurate manner. IFQ programs in other countries have taken the government role a step farther by establishing government-operated weigh stations where all catch must be weighed and logged prior to processing. However, such a government-intensive system is likely not practical given the far-flung nature of the GOA groundfish fishery and the isolated location of many processors. Therefore, the GOA rationalization program will likely need to rely on a system of industry-reported landings with oversight by NMFS Enforcement and/or observers, or a new system such as government weighmasters.

Regardless of who is responsible for the oversight, a catch monitoring program for GOA groundfish landings is likely to contain the following types of requirements:

- Sorting requirements to ensure that multi-species groundfish landings are properly sorted by species prior to weighing.

- Handling requirements to ensure that the flow of fish from the offload point to the scale can be observed and fish cannot be diverted into the factory without being weighed.

- Weighing requirements to ensure that all groundfish IFQ species are properly weighed on approved scales, and that fish do not enter the factory without being weighed.

- Scale requirements to ensure that scales are properly calibrated and are of an approved type certified by NMFS or the State of Alaska.

- Reporting requirements to ensure that IFQ landings are properly reported to NMFS.

- Recordkeeping requirements to ensure that scale receipts and other associated records are maintained for possible future auditing or inspection.

Monitoring groundfish discards by catcher vessels or full retention requirements for all IFQ species

Groundfish discards are among the most difficult fishing activities to estimate with accuracy and precision. At present, while both catcher vessel operators and observers are required to report discards, neither is required to actually measure discards in any systematic way. Vessel operators must report their groundfish discards in their daily fishing logbooks. However, NMFS does not provide any guidance or measurement standards for generating such estimates. Therefore, in most instances, the number reported in the vessel's logbook is simply the skipper's "guestimate" and is not based on any actual weighing or measurement of fish prior to discarding.

Likewise, NMFS observers are also required to report discards or the "percent retained" for each groundfish species or species group. However, observers do not generally attempt to weigh or otherwise measure the exact quantities of groundfish that are discarded by vessels. This is because other tasks such

as species composition sampling and PSC bycatch estimation are given a higher priority. The 2003 Groundfish Observer manual instructs observers that

> "Percent retained is only an estimation, and your effort and time spent obtaining it should be minimal! Percent retained, by species, is often difficult to estimate because discard can happen in a variety of places. Make your estimation based on what you see happening, on a haul by haul basis. Potential types of discard include fish falling off belts, dumping large portions of nets at sea and size sorting fish."[2]

The West Coast Groundfish Observer Program has traditionally placed a higher emphasis on estimating groundfish discards, as discard estimation is a primary reason why observers are deployed in the west coast groundfish fishery. To this end, the West Coast Groundfish Observer Program has established additional standards and procedures for discard estimation by observers. If the discard volume is low enough, observers sort and weigh all bycatch prior to discarding. At higher levels of discards, observers and/or crew members transfer groundfish into baskets prior to discarding and use an average basket weight to estimate the total amount discarded. At the highest levels of discards, observers are forced to use the same types of visual estimation methods used by groundfish observers in the North Pacific.

While the methods used to estimate discards in the west coast groundfish fishery could be used to improve discard estimates in the GOA groundfish fishery, they may not be practical on higher-volume vessels without considerable additional effort and equipment, and the diversion of observers from existing duties such as PSC estimation. On larger vessels that handle higher volumes of groundfish, equipment such as conveyer belts and flow scales may be the only viable method to obtain precise and accurate estimates of discards.

Under the GOA rationalization alternatives, the Council is currently considering a variety of retention requirements for IFQ groundfish that range from no retention requirement to 100% retention for all IFQ groundfish species. The decision about whether to allow at-sea discards of groundfish IFQ species depends largely on whether at-sea discards of IFQ groundfish species can be reliably measured. Without reliable methods to measure at-sea discards of IFQ species, vessel operators will have no reliable way to determine when they have reached their IFQ for a particular species, and managers will have no way to determine when an IFQ has been reached or exceeded.

The only alternative to at-sea measurement of groundfish discards is to prohibit at-sea discards of IFQ groundfish so that the entire IFQ catch can be weighed at the processor. Existing improved retention/improved utilization (IR/IU) regulations already prohibit the discarding of pollock, Pacific cod, and shallow water flatfish in the GOA and could easily be extended to other IFQ groundfish species. Absent a reliable method of measuring at-sea discards on both observed and unobserved catcher vessels, the Council should consider requiring full retention of all IFQ groundfish species so that IFQ catches can be properly monitored and accounted.

However, it is not necessary to extend full retention requirements to species that are not managed under the IFQ or co-op program because such species could be managed could be managed using aggregate

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[2]"2003 North Pacific Groundfish Observer Manual."North Pacific Groundfish Observer Program. AFSC, 7600 Sand Point Way N.E., Seattle, Washington, 98155., page 4-23.

data as is currently done today. Non-IFQ species could include underutilized groundfish species such as arrowtooth flounder, and non-allocated species such as grenadier. Species composition sampling by observers could provide sufficient information to manage such species in the aggregate so there would be no need to retain these species for weighing at the processor.

A full retention requirement for IFQ groundfish species is not without its own monitoring and enforcement issues. It is far easier for an observer to monitor compliance with full retention requirements than to estimate groundfish discard amounts, because monitoring compliance with a full retention requirement simply means watching to see that no groundfish are being discarded. However, without an observer on board it may be simply impossible to monitor whether an operation is illegally discarding groundfish. Of course, this is already the case for the current retention requirements for pollock, Pacific cod, and shallow water flatfish. Extending retention requirements to other species such as rockfish would not raise new issues or problems that are not already present in the existing IR/IU program. In reality, if unobserved vessels chose to discard IFQ groundfish, there is probably little that can be done to detect such activity unless remote monitoring techniques such as video surveillance are used

Monitoring groundfish landings by catcher processors

Measuring the catch of IFQ species by catcher processors is substantially more difficult than for catcher vessels because of space constraints and the difficulty of taking accurate measurement on a moving vessel. In the quota-based programs established to date, NMFS has used a variety of approaches to measure individual quota harvests on catcher processors. In the halibut/sablefish IFQ fishery NMFS requires that all IFQ species be retained and all IFQ products be weighed and reported at the time of offload. The total catch of IFQ halibut and sablefish is then determined by extrapolating product weights to round weights using standardized PRRs. Both the CDQ and AFA programs in the Bering Sea require catcher processors to weigh all groundfish onboard the vessel using NMFS certified scales. However, the catcher processors operating in the CDQ and AFA fisheries tend to be large factory trawlers whereas the catcher processors operating in the halibut/sablefish IFQ fishery tend to be much smaller freezer longline vessels. In addition, catch measurement using at-sea flow scales is most effective in single species fisheries such as the pollock fishery where bycatch is minimal and easily deducted from the scale weights to generate species-by-species catch totals. Measuring the total catch of each species in a multi-species trawl fishery is much more difficult, even with onboard flow scales. Either the catch must be sorted by species prior to weighing, or the unsorted catch must be weighed and a basket sample taken to determine the species composition of the catch.

In developing a groundfish catch monitoring program for catcher processors, the Council and NMFS will need to consider the size and type of catcher processors that operate in the GOA to come up with a cost-effective and appropriate monitoring program. The Council may wish to consider a variety of monitoring approaches depending on the size, gear type, and target fishery of the catcher processor. In any event, NMFS has considerable experience with monitoring individual groundfish quotas on a variety of type of catcher processors. The rationalization program in the GOA is unlikely to raise issues that have not already been faced and addressed to some extent in the halibut/sablefish, CDQ, and AFA fisheries.

Monitoring groundfish discards by catcher processors.

The problems with measuring discards described in detail for catcher vessels also apply to catcher processors. In fact, estimating discards on board catcher processors is even more difficult than on catcher vessels because of the opportunity to discard fish at more locations on the vessel--both on deck

and inside the factory. On a catcher vessel, once the fish have been dumped into the vessel's holds they stay there until offloading. However, all catcher processors have one or more discard chutes below decks where bycatch and the heads and guts of processed fish are discarded. Therefore, the rationale for requiring full retention of all IFQ groundfish species on catcher vessels also would apply to the catcher processor fleet. On the other hand, if flow scales are used to weigh all groundfish prior processing, then discard estimation would become unnecessary because the scales would be used to measure the total catch of IFQ groundfish. Groundfish discards would, therefore, be less of an issue on catcher processors that use flow scales to monitor IFQ harvests, than on catcher processors that use back-calculated production reports to estimate discards.

1.1.2 Halibut PSC

Under the GOA rationalization alternatives, halibut is the only PSC species for which individual vessel harvest shares would be assigned. Under the current management regime in the GOA, aggregate PSC limits have not been established for salmon, crab, and herring, although retention of those species is, of course, prohibited.[3] This discussion assumes that halibut would be the only PSC species in the GOA for which individual harvest shares would be allocated to either individual vessels or cooperatives. However, the issues associated with monitoring halibut bycatch also would apply to crab and salmon, should the program be extended to those other PSC species.

In the GOA groundfish fishery, halibut PSC is currently allocated among fisheries and gear types in the annual harvest specifications. Under the current management program, inseason halibut bycatch is estimated by using a formula that extrapolates the observed estimates from vessels that carry observers to the portion of the fleet that is unobserved. This system is based on the assumption that observed and unobserved vessels operate in a similar manner in open access fisheries. This system is designed to provide aggregate estimates of halibut bycatch on a fishery-by-fishery basis and is not intended to provide precise estimates of halibut bycatch on an individual vessel basis, either for the observed or unobserved vessels.

While extrapolation of data from observed to unobserved vessels may be appropriate for managing halibut PSC in open access fisheries, it is not likely to be a viable monitoring approach in rationalized fisheries regardless of whether or not halibut PSC is allocated to individual vessels. This is because the basic assumption in open-access fisheries-- that observed vessels are operating in a similar manner as unobserved vessels--can no longer be made in a rationalized fishery where each vessel operator is free to chose when and where to conduct his fishing activity. This is especially true in cooperative fisheries where members are no longer competing against each other in a race for fish but have an incentive to work together to ensure that bycatch rates on observed vessels are as low as possible.

[3]The Council has indicated that it intends to develop additional bycatch measures for crab and salmon within the GOA rationalization program. However, at this time, individual vessel harvest shares have not been proposed for those PSC species. Management options for crab and salmon are scheduled to be discussed at the October 2003 Council meeting.

Statistical issues related to the design of an individual vessel halibut PSC harvest share program

The GOA rationalization alternatives include options under which under which halibut PSC harvest shares would be allocated to individual vessels or cooperatives. Under such a program, NMFS would monitor halibut bycatch rates for individual vessels or cooperatives to ensure that harvest shares are not exceeded. The level of monitoring required to operate the program depends on a variety of factors that include sampling bias and precision, enforcement requirements, and operational requirements for cooperatives.

Sampling bias. One of the biggest concerns in developing a PSC monitoring program is the elimination of sampling bias. Bias can occur at a variety of levels within a sampling program including: (1) the choice of which portion of the haul to sample (2) the choice of which hauls to observe on a vessel, and (3) the choice of which vessels are observed and unobserved. The Observer Program expends considerable effort to ensure that unbiased sampling occurs onboard each vessel. These include training and instructions to observers on how to collect samples randomly from various portions of each sampled haul, and the use of random sampling schedules to govern which hauls are sampled during a fishing day.. Under a rationalization program, concerns about bias at the vessel level could increase because individual vessel operators would have a greater incentive to attempt to bias observer samples through activities such as pre-sorting PSC. While such activities are, of course, already illegal, increased vigilance would likely be necessary to ensure that attempts to bias sampling are not successful. Some vessels operating in the BSAI have already demonstrated a willingness to deliberately bias PSC sampling by pre-sorting halibut in an attempt to avoid VIP program violations or extend fishing seasons.

The greater concern regarding sampling bias is in the choice of which vessels to observe. In open access fisheries with less than 100% observer coverage, the assumption is that all vessels are competing equally in a race for fish and therefore, the fishing practices on observed vessels are likely to be fairly representative of unobserved vessels operating with the same gear type in the same time and area. In a rationalized fishery, this assumption can no longer be made for a variety of reasons. First, fishing effort in rationalized fisheries tend to be much more dispersed in both time and space which means that the activities of observed vessels are less likely to be representative of unobserved vessels. Second, in a cooperative fishery, vessels are by definition "cooperating" with each other and have both the incentive and ability to bias sampling by ensuring that observed vessels get lower bycatch rates than unobserved vessels. Finally, in a cooperative the level of aggregation is much lower than in an open access fishery where the observations from all the observed vessels in a fishery might be aggregated to determine fishery-wide bycatch rates. If the level of aggregation is to a cooperative with much fewer vessels, the possibility of bias increases.

Resolving concerns about sampling bias will likely require significant increases in observer coverage relative to the current levels. Because bias is difficult or impossible to measure, there may be no way to effectively address it other than to eliminate it entirely. The most obvious way to eliminate bias between observed and unobserved vessels is to require 100% observer coverage. The question is whether concerns about bias can be adequately addressed at coverage levels less than 100%. That question cannot be answered here but will require considerable additional analysis. Some sources of bias could be identified and eliminated through the use of GPS-integrated electronic fishing logs that provide NMFS with better information on when and where vessels are fishing. However in small cooperatives where vessels use different gear types and operate in different target fisheries in different areas during different times of the year, there may be no way to effectively address the problem of bias other than to require

100% observer coverage. Or alternatively, to require the observed and unobserved vessels in a cooperative to use identical gear and fish side-by-side in a group so that the observed and unobserved activities are comparable.

Sampling precision. Precision refers to the extent to which bycatch estimates are likely to vary in repeated sampling. The standard statistical measure of precision is the *coefficient of variation (CV)*, which is the ratio of the square root of the sample variance (i.e. the standard error) to the estimate of the sample mean. By using this measure, one is able to compare the variances of distributions that have large differences in their means or units of measurements. For example, a CV of 30% implies that the size of the standard error is 30% as large as the sample mean. Smaller CVs indicate greater precision. Alternatively CVs of 100% or greater have poor precision with the standard errors being equal to or larger than the estimated mean. The precision of bycatch estimates can be increased by increasing the size and frequency of the samples taken. Practical limitations on observer workloads limits the extent to which sampling precision can be increased on a boat with a single observer. Increasing the coverage levels in a fishery is one method of increasing sampling precision. Technological improvements in sampling methods that allow observers to handle larger volumes of fish would be another way to increase sampling precision.

Establishing minimum acceptable levels of sampling precision may be necessary to successfully implement individual vessel PSC harvest shares. The minimum acceptable level of sampling precision will depend on a variety of factors including (1) conservation requirements, (2) enforcement requirements, and (3) the operational requirements of vessels and cooperatives.

Conservation of the halibut resource requires that the total estimated PSC from the groundfish fishery does not vary from the overall PSC limit to an extent that would raise conservation concerns. A recent NMFS report on bycatch monitoring provides an extensive discussion on the use of precision estimates in bycatch management and suggests that a precision goal of CVs of 20-30% is appropriate for aggregate annual bycatch estimates that are used for traditional management purposes.[4] If this precision goal of a CV of 20% is applied to the GOA groundfish fishery, we would be 84% certain that the actual annual halibut bycatch is within 20% of the estimate, and 98% certain that it is within 40% of the estimate. Translated to actual numbers, if the estimated annual bycatch is equal to the annual PSC allocation of 2,300 mt (i.e. if the entire halibut PSC allocation is taken), that would mean we would be 84% certain that the actual bycatch of halibut in the GOA is between 1,840 mt and 2,760 mt and 98% certain that it is between 1,300 mt and 3,220 mt.

Effective enforcement of individual vessel halibut PSC shares will require that bycatch estimates for individual vessels or cooperatives be precise enough to ensure that violations can be successfully prosecuted. This is an important question that must be thoroughly analyzed before a program of individual vessel halibut PSC harvest shares can be developed and implemented. When the vessel incentive program (VIP) program was under development, NMFS undertook considerable statistical analysis to determine the minimum levels of sampling that would be required to produce bycatch rates estimates that are acceptably precise for enforcement purposes. In a halibut PSC harvest share program, bycatch estimates must be precise enough so that when a case is taken to court, the government can adequately prove that the alleged violation actually occurred. If the sampling regime is so imprecise that

[4]"Evaluating Bycatch: A National Approach to Standardized Bycatch Monitoring Programs. NMFS." National Marine Fisheries Service, Silver Spring, MD, June 2003.

there is reasonable doubt about whether the vessel in question actually exceeded its PSC harvest share, then the government will be unable to prove that a violation occurred. The analytical work done in support of the VIP program may provide some information on the minimum acceptable levels of precision required to make a halibut PSC harvest share program enforceable. However, because the VIP program and the proposed PSC harvest share program are sufficiently different, considerable analysis will be necessary to determine what kind of minimum levels of sampling will be required to enforce the proposed halibut PSC harvest shares.

Finally, effective implementation of a system of halibut PSC harvest shares will require that bycatch estimates are precise enough to satisfy the operational needs of fishermen and cooperatives. In a fishery cooperative where quotas are traded and sold among co-op members, monitoring must be precise enough to ensure that the fishermen are actually able to catch the quotas that they have obtained. The levels of precision required to successfully operate a cooperative may far exceed the level that might be required for conservation purposes alone. The AFA catcher processor pollock fishery in the BSAI provides an excellent example of this situation. If the objective in the AFA pollock fishery was simply to manage the pollock TAC for conservation purposes, then a CV of 20% or greater might be perfectly acceptable for pollock TAC management given that the ABC and OFL are more than 20% greater than the TAC. Managing the pollock TAC to a CV of 20% would ensure that the stock is not overfished.

However, the AFA catcher processor fleet is also managing a cooperative in which pollock quota is bought and sold by the metric ton. Pollock fishermen want to be certain that their actual harvests are equal to the quotas that they hold and desire a level of monitoring precision that far exceeds that which would be required for conservation purposes alone. To this end, the AFA mandates that all pollock harvested by AFA catcher processors be weighed on NMFS-certified scales. These scales must be tested daily and be calibrated to be accurate to within 0.5% or the vessel cannot operate. Under this system, a vessel operator can be reasonably certain that his actual catch of pollock is within 0.5% of his reported scale weight. Concerns about bias were also a reason for the scale requirements and increased coverage in the AFA and CDQ fisheries.

The level of precision attained in the AFA and CDQ pollock fishery far exceeds anything that would be required for conservation purposes, but ensures that when a company invests in AFA or CDQ pollock quota it will be able to harvest all of it. The AFA cooperatives could not function if the catch estimation method used in the pollock fishery was simply designed to produce an aggregate annual CV of 20% because the individual catch estimates on individual vessels could be highly imprecise and vary substantially from vessel to vessel. No fisherman (unless he was a gambler!) would want to purchase 100 mt of pollock quota to fish if the monitoring program is so imprecise that his actual catch could range between 20 and 180 mt before he was shut down, and he has no idea in advance as to which end of the range his actual catch will fall.

With respect to a cooperative-based halibut PSC harvest share program of the sort envisioned under GOA rationalization, the acceptable level of precision may well depend on the structure of the cooperatives and whether they are voluntary or mandatory. In a system of voluntary cooperatives in which all of the members of a cooperative have freely chosen to associate with each other and "uncooperative" members can be excluded, a less precise sampling program may be acceptable. This is because the individual members of the cooperative may have faith that they will all individually act in the best interests of the cooperative and follow the best fishing practices to reduce bycatch. However, in a system of mandatory cooperatives in which fishermen do not have the flexibility to chose their own membership, and are forced to accept "uncooperative" members that they would otherwise not wish to

associate with, a more precise sampling program may be necessary. In such an instance, the member vessels may be unwilling to have their bycatch rates pooled because one bad actor could drag down the cooperative. Instead, the members way want a sampling regime that is precise enough to allow the cooperative to regulate vessels individually and isolate out those with higher rate.

How good must the halibut bycatch monitoring program be?

The issues of sampling bias and precision are therefore central to the design of a bycatch monitoring program for GOA rationalization. The purpose of this discussion paper is not to identify what type of sampling or what level of observer coverage is necessary to successfully implement the proposed halibut PSC harvest share program and eliminate concerns about bias and precision. Rather, the purpose of this discussion is to emphasis that sampling bias and precision must be major factors the in the analysis and design of a halibut PSC monitoring program that relies on observer sampling to meet its objectives..

Given the problems associated with sampling bias and precision, a halibut PSC harvest share system that is based on observer coverage is likely to be the most difficult aspect of the GOA rationalization program to design and implement. This is especially so if the program relies on at-sea observers to produce vessel-by-vessel bycatch estimates. It may be the case that a program that relies on observer data may be too costly to be economically viable in some GOA groundfish fisheries. This is especially true for those sectors of the groundfish fishery in which smaller vessels predominate.

At the same time, maintaining the current system of aggregate PSC quotas is not a viable option either, because maintaining the current fishery-based PSC quotas would simply result in a race for halibut PSC in those fisheries that are PSC-limited. Many of the benefits of rationalization would be defeated. In light of this dilemma, section 2.0 explores some alternative approaches to halibut bycatch management that may merit consideration, if the proposed system of halibut PSC harvest shares proves to be unworkable for some or all of the sectors of the GOA groundfish fishery.

Individual vessel vs cooperative PSC harvest shares

Some fishermen have suggested that a halibut PSC harvest shares issued to cooperatives would require less monitoring than harvest shares issued to individual vessels. However, the extent to which this is true depends largely on the type of cooperatives authorized under the program, and their objectives for internal vessel management. It also depends on whether the issues associated with sampling bias can be adequately addressed with less than 100 % observer coverage.

The type of cooperatives formed under GOA rationalization will significantly influence the type of monitoring program required. At one extreme would be a cooperative program with no restrictions on membership, in which fishermen would be free to organize with any other like-minded individuals that they chose to associate with, and would also be free to exclude any individuals that they chose not so associate with. At the other end of the extreme would be a mandatory cooperative program in which each fisherman is only eligible to join a single cooperative linked to a single processor, and in which fishermen would be unable to exclude individuals that they do not wish to associate with.

Under a system of voluntary cooperatives that allows complete freedom of association, it is likely that some cooperatives could form in which the members trust each other to follow all of the agreed-upon fishing practices. In such a cooperative, the members may be willing to accept a single bycatch rate that does not differentiate between vessels, knowing that they would have no way to reward or penalize

individual vessels with higher or lower bycatch rates, or that do not follow agreed-upon practices. Such a cooperative would likely need to operate with some sort of profit-sharing agreement in which all the members share the risks and profit from fishing jointly, because individual vessel statistics could not be discerned, and exchanges of quota between co-op members would be impossible.

However, under a system of mandatory cooperatives in which fishermen are not free to chose their associates, and would have no ability to exclude bad actors, industry is much more likely to desire a monitoring regime in which individual vessel bycatch rates can be determined. This is true even if the PSC harvest share is issued to the cooperative in the aggregate. Under such a system, cooperatives are much more likely to want to subdivide their aggregate halibut PSC harvest share so that each individual vessel receives its own allocation, and so that each individual vessel's halibut bycatch can be tracked.

To date, all of the cooperatives formed under the AFA have been of the latter variety in that they track their individual harvests of pollock and sideboard species so that quota shares can be exchanged between members and individual members can be penalized for exceeding their own allocations. In effect, each cooperative operates its own private IFQ system under which the cooperative allocates quota to each individual vessel and monitors each vessel's fishing activity.

1.1.3 Monitoring the time and location of fishing activity

Numerous regulations in the GOA govern the time and area of fishing activity. These include closed areas such as Steller sea lion protection zones, no-trawl areas, seasonal restrictions on fishing activity, and a host of other regulations that govern when and where fishermen may fish. During open access fisheries when numerous vessels are operating in the same general area for a limited fishing season, these types of regulations are possible to monitor using traditional methods such as Coast Guard overflights. However, in a rationalized fishery where fishermen may be fishing in widespread locations throughout the year, enforcement of time and area closures with traditional methods becomes more difficult. As a result, technological monitoring methods such as VMS may become more necessary under GOA rationalization than they might otherwise be in traditional open access fisheries.

A system of GPS-integrated electronic logbooks in which fishermen report their fishing activity electronically may also assist in tracking of fishing activity. Such a system also could help managers deploy observers in the most effective manner so that the areas where vessels are fishing receive adequate coverage. If managers have better information about where unobserved vessels are fishing they can make better decisions about when and where to deploy observers to obtain comprehensive coverage.

1.2 Monitoring fleet-wide fishing activity

While IFQ groundfish and halibut PSC would need to be monitored at the individual vessel level under most of the rationalization alternatives under consideration, much of the other data necessary for the management of the program could still be aggregated to the fleet or fishery level. The types of data that could be aggregated to the fishery level include:

- Marine mammal takes and observations
- Incidental bycatch of seabirds
- Catch and bycatch of non-IFQ groundfish and non-quota PSC species
- Other scientific data collection programs normally conducted by observers.

1.2.1 Marine mammal and seabird monitoring

A variety of federal laws and regulations require that NMFS monitor takes and interactions with marine mammals and other protected species such as seabirds. In the GOA groundfish fishery, this is currently accomplished through the same observer coverage that is used to monitor groundfish catch and PSC bycatch. A new monitoring program for GOA rationalization will need to continue to collect data on marine mammals and seabirds to the extent required by existing laws and management programs.

The issue is whether marine mammal and seabird monitoring needs to be done at the individual vessel level as with IFQs and halibut PSC harvest shares, or whether marine mammal and seabird data can continue to be collected and aggregated at the fishery level. Given that the GOA rationalization program will not sub-allocate marine mammal and seabird allowable takes down to the individual vessel level, there is probably no reason to increase marine mammal and seabird monitoring beyond the level that is currently considered to be adequate for the existing open access fisheries.

This means that some observer coverage will continue to be required under GOA rationalization in order to meet marine mammal and seabird monitoring obligations. However, GOA rationalization is unlikely to require increased marine mammal and seabird monitoring, unless rationalization leads to changes in fishing behavior that lead to increased concerns about marine mammal and seabird interactions. The effects of rationalization on marine mammal and seabird interactions will be a subject for analysis in the EIS.

1.2.2 Monitoring catch and bycatch of non-IFQ and non-quota PSC species

Under GOA rationalization, individual harvest shares would not necessarily be issued for each groundfish and PSC species. For underutilized groundfish species such as arrowtooth flounder,[5] or non-allocated species such as grenadier, it may be appropriate to continue monitoring removals in the aggregate on a fishery-by-fishery basis rather than attempting to estimate removals on an individual vessel-by-vessel basis. The same holds true for PSC species such as crab, salmon and herring for which individual vessel harvest shares are not assigned.

If managers are only concerned with estimating the total removals of these species at the fishery level, and not concerned with monitoring individual vessel quotas, then the monitoring system for such species could rely on aggregated data. For example, rather than attempting to determine the exact tonnage of arrowtooth flounder that each groundfish vessel has harvested, managers might simply use extrapolated data from observed vessels to estimate total arrowtooth removals from the GOA.

Because individual vessel data are unnecessary to monitor species for which individual vessel quotas have not been assigned, there is no compelling monitoring reason to extend IR/IU requirements to such species. In the case of non-IFQ groundfish, fishery-wide estimates of total removals could be generated using existing methods without the requirement that each vessel retain all of its non-IFQ groundfish to be sorted and weighed at the processor along with its IFQ species. Therefore, the level of monitoring required to estimate removals of non-IFQ species is considerably lower than that required to monitor groundfish IFQs and halibut PSC harvest shares.

[5]Under some of the options under consideration, arrowtooth flounder could also be an IFQ species. In this case, the total catch of arrowtooth flounder would need to be monitored on a vessel-by-vessel basis and an effective method of measuring arrowtooth discards would need to be developed if full retention of arrowtooth flounder was not required.

1.2.3 Other data collection programs

Observers also collect a variety of other types of data to support ongoing management needs. These include collection of length frequencies and otoliths to support age and growth studies, collection of stomach samples, and collection of tagged fish. These types of data collections will continue to be necessary under GOA rationalization to support the overall management of the fisheries, however there is nothing inherent about GOA rationalization that would require these types of data collection programs to increase.

1.3 Monitoring cooperative formation and operation

The experience with designing and implementing the AFA cooperative program in the BSAI suggests that considerable efforts will need to be undertaken under GOA rationalization to monitor the formation and operation of cooperatives. The extent to which this is necessary depends largely on how the program is designed. For example, in the AFA pollock fishery, NMFS continues to monitor and regulate the catcher processor and mothership sectors of the BSAI pollock fishery as if it were an open access fishery. Other than the requirement to submit annual reports, mothership and catcher processor cooperatives are largely unregulated in the sense that NMFS does not review or approve their membership, and does not issue them individual allocations.
In contrast, the AFA inshore catcher vessel cooperatives are highly regulated because the AFA spells out specific membership requirements for these cooperatives and a specific formula for allocation of quota to each inshore cooperative. Therefore, NMFS must spend considerable time overseeing the formation of inshore cooperatives to insure that each inshore cooperative contains only the members authorized by law and that the allocation to each inshore cooperative is based on the formula spelled out in regulation. NMFS must also review each inshore catcher vessel cooperative's contract to ensure that it contains all of the elements required by the AFA and implementing regulations. Finally, NMFS must also monitor the aggregate landings for each inshore cooperative to ensure that each cooperative stays within its annual allocation.

The extent to which cooperative formation and operation will need to be monitored in the GOA rationalization program depends largely on the extent to which the program restricts cooperative membership and activity. If cooperatives have no membership or delivery restrictions then less oversight will be necessary. On the other hand, if the program is restrictive with respect to cooperative membership, linkages to processors, delivery restrictions, transfers between cooperatives, and requires that eligible vessels be entitled to join specific cooperatives, then a great deal more oversight and monitoring will be necessary to ensure that cooperatives form and operate in the manner intended.

However, regardless of the level of oversight required, these types of tasks are largely administrative in nature and would likely be accomplished by staff at the NMFS regional office. In the AFA cooperative program, observers and enforcement officers in the field are not generally involved in the task of monitoring the internal structure and operation of cooperatives. Under GOA rationalization, this type of administrative workload will most definitely increase, and could require additional staff to implement. The extent to which this is necessary depends largely on how highly regulated and restricted cooperatives would be under the Council's preferred alternative.

1.4 Monitoring processing activity

Under any type of harvest share or IFQ system, increased monitoring of processors is necessary. This is especially true for the weighing and reporting of IFQ landings as discussed above. Some level of additional oversight will be required to ensure that all landings are properly weighed on scales that are properly calibrated, and that IFQ accounts are properly debited. Alternatives that impose additional restrictions on processing, such as a closed class of groundfish processors, or a direct or indirect system of processing quotas, will require additional monitoring of processing activity to insure that processors do not exceed the limits place on them by regulation. However, the existing halibut/sablefish IFQ program, and the AFA and CDQ programs provide several monitoring approaches that could be applied to GOA rationalization. It is unlikely that GOA rationalization would raise unique and different monitoring issues for processors that have not already been addressed in these three existing quota-based programs.

2.0 Alternative approaches to halibut bycatch management

As discussed above under 1.1.2, implementing an individual vessel halibut PSC harvest share program is likely to be the most difficult and costly aspect of the GOA rationalization program. Because an individual vessel harvest share program for halibut in the GOA has not been extensively developed or analyzed, it is not possible to determine what type and level of monitoring will be required for such a program to operative effectively. However, it seems likely that an observer-based program that attempts to estimate halibut bycatch at the individual vessel level would require 100% or greater observer coverage to achieve the necessary level of precision at the individual vessel level. This type of program would be exceedingly costly given the number and type of vessels currently operating in the GOA groundfish fishery because it could require a ten-fold or greater increase in the number of observers deployed in the GOA groundfish fishery. This level of observer coverage would most certainly not be sustainable through a pay-as-you-go or fee-based program because the costs of such observer coverage could exceed the total net revenues in the fishery. Unless of course the GOA groundfish fleet is dramatically restructured to resemble the large-vessel fleets that operate in the BSAI.

At the same time, maintaining the existing system under which halibut bycatch limits are allocated to different fisheries also is not viable under GOA rationalization. Maintaining the current system of halibut bycatch allocations that are managed through directed fishing closures would defeat the purpose of GOA rationalization, at least for those fisheries in which halibut bycatch is a factor. To do so would simply continue the race for fish because fishermen would be required to race to insure that they catch their IFQ species before the fishery is closed due to halibut bycatch.

Therefore, some alternative approach to halibut bycatch management will be required in order to successfully implement GOA rationalization. If an individual vessel halibut PSC harvest share program monitored by intensive observer coverage is not economically viable, then alternative approaches must be considered. The following discussion introduces a variety of alternative halibut bycatch management and monitoring approaches that may merit additional consideration.

2.1 Alternative monitoring technologies: Digital observers and video monitoring

The use of video cameras to monitor at-sea fishing activity is a relatively new technique, and has only been tried in limited fisheries to date. The approach involves mounting tamper-proof video cameras in various locations on the fishing deck and recording all or a portion of the vessel's fishing activity. A

recently completed pilot program in the Alaska halibut fishery has found video cameras to be extremely useful in monitoring seabird bycatch and compliance with seabird avoidance measures. However, video monitoring alone is unlikely to provide an adequate method to monitor halibut bycatch.

Digital observer technology takes the use of video monitoring one step farther. This technology uses a digital scanner to record multiple images of individual fish for electronic species identification and for length frequency estimates as each fish passes through the scanner on a conveyer belt. The primary developer of this technology is Digital Observer LLC of Kodiak, Alaska. Although this technology is still in the testing phase, it may be an alternative to human observers for some types of vessels and fisheries in the GOA.

The use of alternative monitoring technologies will be a major topic for analysis in the environmental assessment/regulatory impact review currently under preparation for restructuring of the observer program in the GOA. To the extent that such technological approaches show promise for monitoring the GOA groundfish rationalization program, they should be explored further in the EIS currently under preparation for GOA rationalization.

2.2 Industry self-reporting of bycatch

Mandatory logbook reporting requirements are frequently used in fisheries throughout the world. In fact, in the GOA groundfish fishery, the operators of groundfish vessels over 60' LOA are currently required to report estimates of PSC bycatch in their daily fishing logs. The question is whether such self-reporting produces data that is unbiased and precise enough for use in a halibut PSC harvest share program.

NMFS has undertaken several studies that compare self-reported logbook data with data collected by observers in various fisheries throughout the US. All of these studies concluded that self-reported logbook data may not be a reliable method for estimating bycatch. There are a variety of reasons why this is the case. First of all, unlike observers, fishermen are not required to follow any type of random sampling methodology to estimate their level of bycatch. The vessel's estimate, therefore, is simply a visual estimate that is not subject to any methodology. Second, fishermen tend to be focused on the species of economic value in their catch and pay less attention to species that are of less economic value or are discarded. Finally, fishermen would have an obvious incentive to under-report halibut bycatch if they were subject to a harvest share system that was governed by their own bycatch estimates. For these reasons, self-reporting of halibut bycatch is not considered a viable approach to managing halibut bycatch under GOA rationalization.

2.3 Integration with the halibut IFQ program

One approach to managing halibut bycatch is to incorporate it into the existing halibut IFQ program so that vessels would be issued halibut IFQs rather than shares of halibut PSC mortality, and their halibut catch could then be retained for measure and sale at the processor. Given existing and historic halibut fishing regulations, this approach would likely only be viable for fixed gear vessels that could otherwise legally fish for halibut. It would be especially problematic for trawl vessels given that much of the halibut PSC caught by trawl vessels is sub-legal. However, even if limited to fixed gear, this approach would dramatically change the nature of both the existing halibut and groundfish fisheries and would require wholesale changes to both programs. In addition, the harvest shares of halibut PSC mortality allocated to groundfish fishermen would convert to substantially lower amounts of halibut IFQ because

of the difference in mortality rates between halibut PSC caught by longline vessels and halibut caught in the halibut IFQ fishery.

In addition, there are a variety of economic and socio-economic reasons why the Council may not wish to fully incorporate the halibut and groundfish IFQ programs. Nevertheless, it is a potential option for addressing halibut bycatch that could be explored in the analysis, if desired.

2.4 Factoring halibut bycatch into groundfish TAC specifications

The most simple approach to halibut bycatch management would be to incorporate projected halibut bycatch estimates into the TAC setting process. For target fisheries that are limited by halibut bycatch, the TACs could be reduced in advance to the level that the fleet is projected to harvest under a given halibut PSC allocation. This would be a very crude approach to halibut bycatch management, but could be a viable approach in certain small-vessel fisheries where more direct bycatch monitoring with observers is not economically viable.

Under such a system, NMFS could continue to monitor bycatch through some level of observer coverage to determine the actual level of halibut bycatch in the fishery and provide bycatch data that could be incorporated into the following year's TAC specification process. Fisheries that exceed their projected level of halibut bycatch in a given year would see their TACs reduced the following year and fisheries that catch less halibut than projected could see their TACs increased the following year. Such a system would allow groundfish fishermen to fish when and where they wanted in a fully rationalized manner without fear of inseason closure due to halibut PSC. But such a system could provide less incentive to individual vessel operators to reduce bycatch than would a system of individual vessel halibut PSC harvest shares, unless cooperatives organized to keep bycatch rates low.

2.5 Halibut PSC harvest share program based on standardized bycatch rates.

A more sophisticated approach than that identified in 2.4 would be to issue halibut PSC harvest shares to individual fishermen and use model-generated standardized halibut bycatch rates to attribute bycatch mortality to different fishing practices. Under such a system, NMFS would develop a halibut bycatch model that would assign bycatch rates to individual vessels based on such factors as time and area of fishing, gear type, target species, and any additional factors that might also be correlated to halibut bycatch. Such a model could be as sophisticated or simple as the data warrant, and could include data from non-fishery sources such as surveys and abundance estimates.

Under such a model, the entire GOA could be divided up into small subareas for the purpose of halibut bycatch estimation and factors such as gear type, depth, time of year, time of day, and target species could be incorporated as appropriate to determine the estimated bycatch rate for each area, gear type, target fishery, week etc. Conservative (precautionary) baseline rates could be assigned to time/area cells for which bycatch data are lacking, which would mean that industry would have an incentive to ensure that the areas they wish to fish in have adequate observer coverage. A vessel that uses trawl gear to fish for Pacific cod in one area would automatically be assigned a halibut bycatch rate that would be applied against the landed catch of Pacific cod. When the vessel makes its landing, the system would automatically debit the vessel's PSC harvest share account based on the standard rate for that area, time, gear type, etc. A vessel using pot gear to fish for Pacific cod in the same time and area would be assigned a much lower halibut bycatch rate and would have its halibut PSC account debited much less when landing the same quantity of Pacific cod.

Such a system would depend on the ability of NMFS to collect sufficient halibut bycatch data so that the model can reasonably predict bycatch rates by area, gear type, and time of year. Therefore, some level of ongoing observer coverage would be required to track actual bycatch rates so that the model could be updated as necessary. But the level of observer coverage required to develop standardized bycatch rates may be far lower than the level of coverage required to run an halibut PSC harvest share program based on the actual bycatch of each vessel. In fact, such a system is really just a more sophisticated variation on the current halibut PSC management program which extrapolates bycatch rates from observed vessels to unobserved vessels that are fishing in the same time and area.

The advantage to such a system is that it could be far more cost-effective than a system in which NMFS attempts to track actual bycatch rates using observers on each individual vessel. It would also provide more predictability for fishermen who would know in advance that if they fish in a certain manner they can expect to use up a predictable amount of their halibut PSC harvest share. An additional advantage to such a system is that it provides the Council and NMFS a method to encourage the use of fishing methods that are known to reduce halibut bycatch. For example, if a certain type of trawl gear or excluder device is developed that is known to reduce halibut bycatch, that information could be incorporated into the model and fishermen that switch to that gear would be immediately rewarded with a lower bycatch rate. Fishermen would have a powerful incentive to avoid fishing during times and in areas that are known to have high bycatch rates.

Such a system would also encourage additional feedback between fishermen and managers to refine the model. Fishermen who believe that actual bycatch rates for a certain gear type or area are lower than those indicated by the model would have an incentive to come to NMFS and request additional observer coverage in that area to verify their claims. NMFS managers could also watch fishing patterns to determine where observers should be deployed in order to fill holes in the model. NMFS could also conduct research by contracting with fishermen to fish in specific areas with specific gear types in order to supplement data and test new gear types as needed.

While such a system could provide less incentive for individual fishermen to reduce their bycatch in ways that are not reflected in the model, it could be a powerful way to encourage clean fishing practices, to the extent that such high-bycatch fishing practices could be identified and incorporated into the model. Such a program would also be far easier to enforce than one based on actual observed bycatch rates because the regulations would be written to require vessels to live within the model's results, regardless of whether their actual bycatch is higher and lower than the model predicts. Ultimately the success of such a program depends on the extent to which bycatch rates could be predicted based on the time, area, and type of gear used.

2.6 Hybrid program using multiple approaches

Ultimately, the diversity of vessels, gear types, and target fisheries in the GOA may require the Council to consider a hybrid approach that uses different methods halibut bycatch management for different sectors of the diverse GOA groundfish fishery. Any or all of the approaches listed above could be combined in a hybrid program in which the halibut bycatch management method is tailored to each individual fishery as appropriate.

It may well be the case that the diversity of groundfish fisheries in the GOA precludes a one-size-fits-all approach to halibut bycatch management and a hybrid approach is necessary. The suggestions contained in this discussion paper are by no means a comprehensive list. They are only intended to provide a starting point should the Council wish to explore additional alternatives to managing PSC bycatch in the GOA rationalization program.